Section A: 40 marks

Answer **all** questions.

1 Fig. 1a shows the reading when a micrometer screw gauge is completely closed.

Fig. 1b shows the reading when it is used to measure the diameter of the ball bearing.

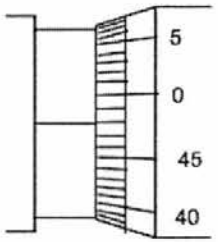


Fig. 1a

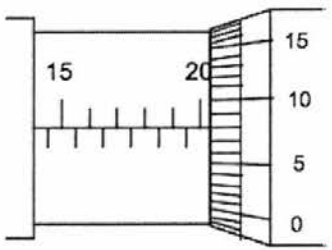


Fig.1b

What is the actual diameter of the ball bearing?

A 20.06 mm **B** 20.10 mm **C** 20.48 mm **D** 20.52 mm

2 Pendulum **A** makes 20 complete oscillations in 10 s.

If pendulum **B** makes 10 complete oscillations in 6 s, which of the following statements is **true**?

A Pendulum **B** is longer than pendulum **A**.

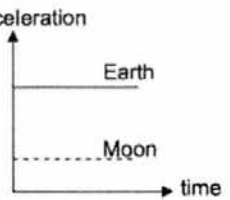
B Pendulum **B** has a shorter period than pendulum **A**.

C The mass of the bob of pendulum **B** is smaller than that of pendulum **A**.

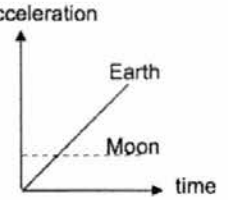
D The angle of swing of release for pendulum **B** is smaller than that of pendulum **A**.

3 A rock weighs 100 N on Earth and 16 N on the Moon. Which diagram shows the acceleration-time graph of the rock dropped from Earth and the Moon?

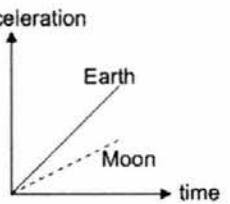
A



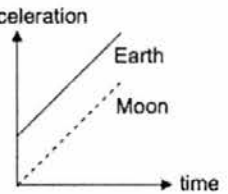
B



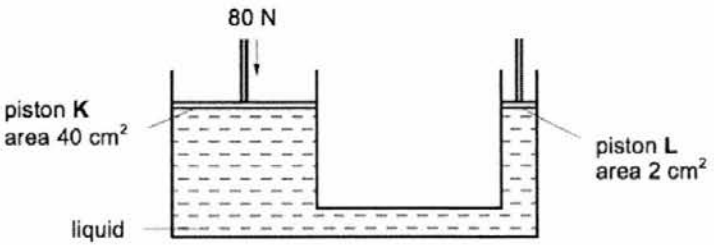
C



D



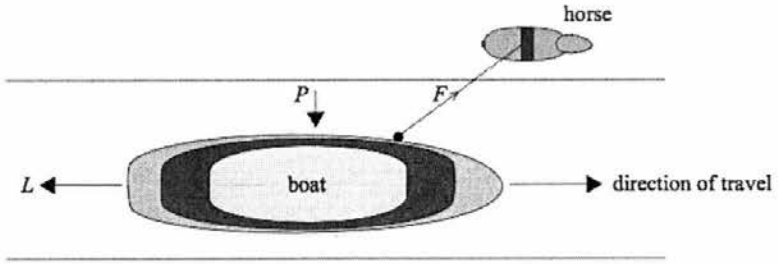
4 The system contains an incompressible liquid. A downward force of 80 N is exerted on the piston **K**.



What will be the upward force on piston **L**?

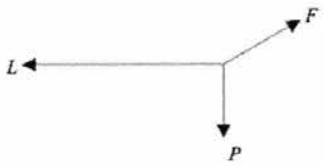
A 1.0 N **B** 4.0 N **C** 40 N **D** 1 600 N

5 A horse pulls a boat along a canal at constant speed in a straight line as shown below.

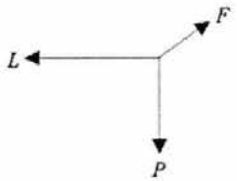


The horse exerts a constant force F on the boat. The water exerts a constant drag force L and a constant force P on the boat. The directions of F, L and P are as shown. Which **one** of the following best represents a free-body diagram for the boat?

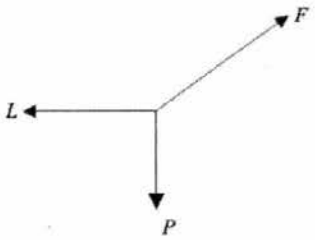
A



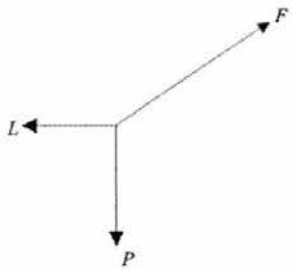
B



C



D



6 What affects the stability of an object?

A only its base area

B only its weight and its base area

C only its location of centre of mass

D only its base area and location of its centre of mass

7 A large electric motor is used to lift a container off a ship. Which of the following quantities are enough to calculate the power of the motor?

A the work done and the time taken

B the current used and the work done

C the force used and the distance moved

D the mass of the container and the distance moved

8 A substance consists of particles that are far apart and moving at high speeds past one another. The average speed of the particles is gradually decreasing and the particles gradually get closer together.

Which of the following best describes the substance?

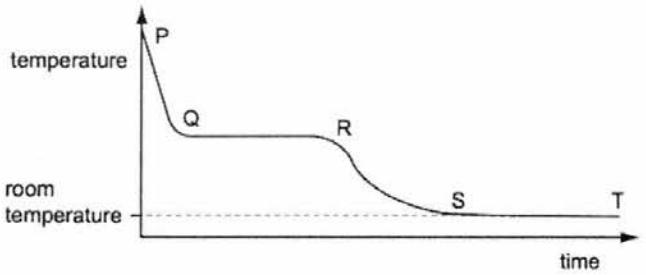
A a liquid being heated

B a liquid being cooled

C a gas being cooled

D a gas being heated

9 The graph shows the cooling curve of a hot substance.



In which part of the curve is latent heat released?

A ST **B** RS **C** QR **D** PQ

10 Which of the following statements about conduction are true?

1 Conduction can transfer thermal energy faster in a denser medium.

2 Conduction can transfer thermal energy faster through good electrical conductors.

3 Conduction cannot happen together with convection.

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

11 An ordinary piece of kitchen aluminium foil is used to wrap food to be cooked in a barbecue fire. The foil has a shiny side and a dull side.

Which side should be on the outside, and why?

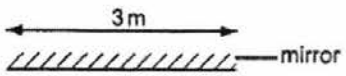
A The dull side should be on the outside because it is a better conductor of thermal energy.

B The dull side should be on the outside because it allows convection currents to be set up.

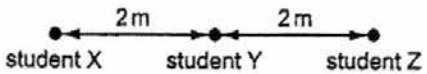
C The shiny side should be on the outside because it is a better emitter of radiant heat.

D The dull side should be on the outside because it absorbs infra-red radiation faster.

12 Three students stand 2 m apart in front of a plane mirror that is 3 m long as shown in the diagram.

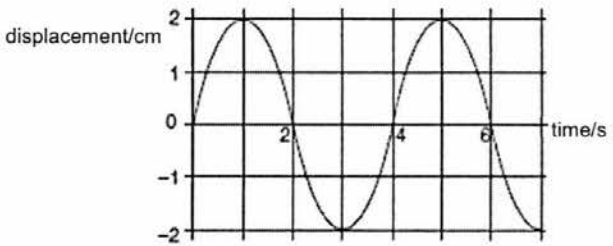


How many student image(s) can student Y see?



A 0 **B** 1 **C** 2 **D** 3

13 The graph shows how the displacement of a particle in a wave varies with time.



Which of the following is correct?

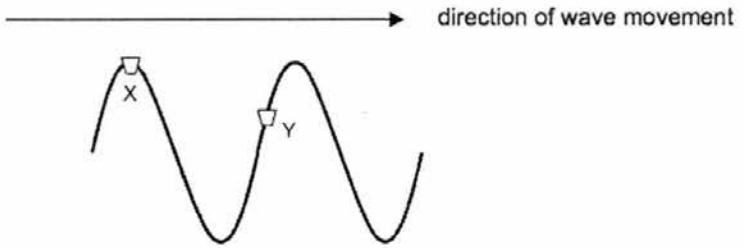
A The wave has an amplitude of 2 cm and a period of 6 s.

B The wave has an amplitude of 4 cm and must be transverse.

C The wave has an amplitude of 4 cm and can be either transverse or longitudinal.

D The wave has an amplitude of 2 cm and can be either transverse or longitudinal.

14 The diagram shows two corks, X and Y, tied to a string. A wave is produced on the string.



What will happen to both corks as the wave passes?

A Both X and Y will move downwards.

B Both X and Y will move to the right.

C X will move upwards and Y will move downwards.

D Y will move upwards and X will move downwards.

15 The frequencies of note R and note S in air are 256 Hz and 320 Hz respectively. Which of the following statements are correct?

1 Note S has a higher pitch than note R.

2 Note S has a shorter wavelength than note R.

3 Note S is louder than note R.

A 1 and 2 only **B** 2 and 3 only **C** 1 and 3 only **D** 1, 2 and 3

16 Fig. 16a shows a resistor connected to a battery, an ammeter and a voltmeter.

The ammeter reading is 0.5 A and the voltmeter reading is 3.0 V.

A second identical resistor is now connected in parallel with the first resistor, as shown in Fig. 16b.

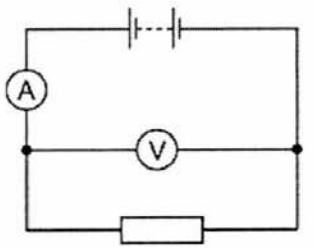


Fig. 16a

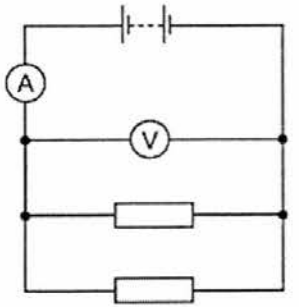
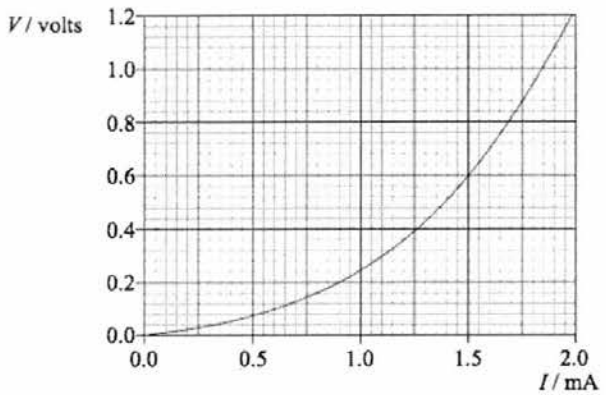


Fig. 16b

What are the ammeter and voltmeter readings in the circuit shown in Fig. 16b?

	ammeter reading/ A	voltmeter reading/ V
A	0.5	6.0
B	0.5	3.0
C	1.0	3.0
D	1.0	1.5

17 The graph below shows the variation with current I of the potential difference V across a filament lamp.



What is the resistance of the lamp when $I = 1.5$ mA?

A 0.40 Ω **B** 0.95 Ω **C** 400 Ω **D** 950 Ω

18 Many electrical appliances have metal cases.

To prevent the case from becoming 'live', with the possibility of an electric shock, the earth wire of the electric cable is attached to the case.

How does the earth wire prevent an electric shock?

A It allows a current to flow to earth, so that the appliance continues working.

B It prevents the fuse from blowing.

C It reduces the current to a safe level.

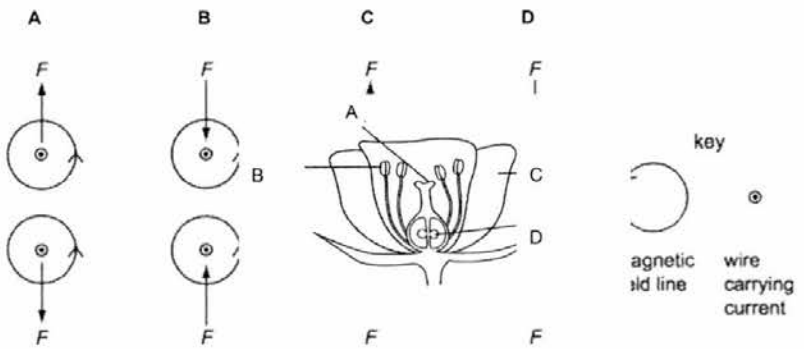
D It allows a large current to flow to earth, blowing the fuse.

19 The total cost of operating a 2 000 W heater and a 100 W bulb for 4 hours at 20 cents per kWh is _____.

A $0.80 **B** $1.68 **C** $160 **D** $168

20 The diagrams show the forces F between two wires carrying currents out of the page. The magnetic fields close to the wires are also shown.

Which diagram is correct?



Section A: 45 marks

Answer **all** the questions in the spaces provided.

1(a) Circle the quantities in the list below that are scalars.

acceleration force mass speed weight [1]

1(b) A tin containing 5 000 cm^3 of paint has a mass of 7.0 kg. Find the density of the paint in kgm^{-3} if the mass of the empty tin including the lid is 0.50 kg.

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density = ... [2]

2 Fig. 2.1 shows a student doing a press-up. A total force *F* acts upwards on his hands. There is also a force acting upwards on his toes.

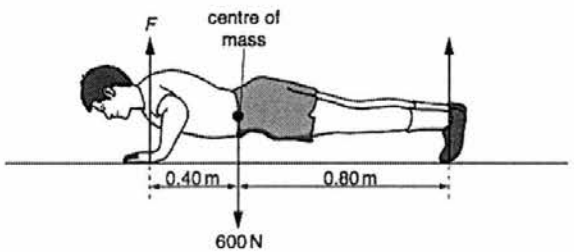

Fig. 2.1 (not to scale)

The weight of the student is 600 N and this force acts downwards from his centre of mass.

(a) **(i)** Explain why the student does work as his body rises from the ground.

.....

.....[1]

(ii) State the form of energy that the student uses to do this work.

.....[1]

(b) At the position shown in Fig. 2.1, the student is stationary.
The weight of the student causes a moment about his toes.

(i) Find the moment of the weight of the student about his toes.

moment = ... [1]

(ii) Calculate the value of the force *F*.

F = ... [2]

3 Fig. 3.1 shows a car of mass 1 500 kg moving along the road at constant velocity. The forward driving force is 500 N and the opposing force is *f*.

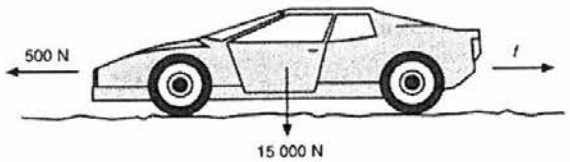

Fig.3.1

(a) State the magnitude of the opposing force *f*, showing clearly how you arrive at your answer.

opposing force = ... [2]

(b) The forward driving force increases to 800 N. Calculate the acceleration of the car.

acceleration = ... [2]

4 Fig. 4.1 shows the path of a ray of blue light as it passes through a glass prism.

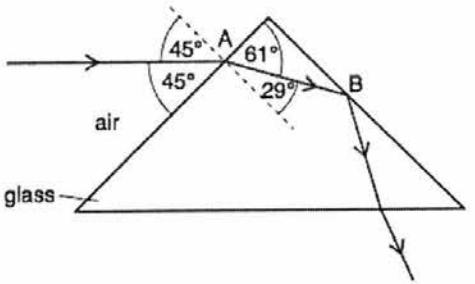

Fig. 4.1

(a) Using angles from Fig. 4.1, calculate the refractive index of the glass. Hence, find the critical angle of the glass.

refractive index = ... [1]

critical angle = ... [1]

(b) Explain why the ray does not emerge from the prism at B.

.....

.....

.....

.....[2]

5 Fig. 5.1 shows a "bug viewer" that consists of a plastic chamber with a lens in the lid. It is used to obtain a magnified view of small insects placed on the base of the chamber.

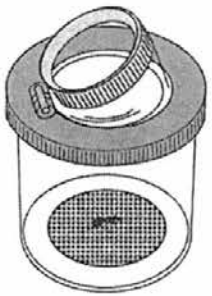

Fig. 5.1

(a) Name the type of lens that should be used.

.....[1]

(b) The lens used has a focal length of 60 mm and the base of the chamber is 30 mm from the lens.

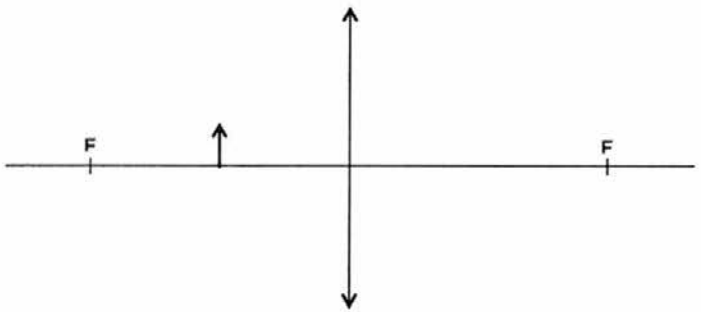

Fig. 5.2 (not to scale)

By means of a ray diagram, complete Fig. 5.2 to show the position of the image of the bug and label it, **B**.

[3]

6 Red light has a wavelength of 7.0×10^{-7} m.

(a) Calculate the frequency of this light, clearly stating the value of any constant used in the calculation.

frequency = ... [2]

(b) State a different component of the electromagnetic spectrum that has a wavelength greater than that of red light and name its use.

wave.....

use.....

[2]

7 When a balloon is rubbed on hair, the balloon becomes negatively charged. The balloon is shown in Fig. 7.1.

Fig. 7.1

(a) Explain how rubbing causes the balloon to become negatively charged.

.....

.....

.....[2]

(b) Explain why the hair is pulled towards the balloon.

.....

.....

.....[2]

8 The motor of a cordless electric drill is powered by a rechargeable battery with an electromotive force (e.m.f.) of 18 V. When the drill is used, the power supplied to the motor is 450 W.

(a) Explain what is meant by *e.m.f.*.

.....

.....

.....[1]

(b) A workman uses the drill for 90 minutes.

Calculate

(i) the electrical energy supplied to the motor,

energy = ... [2]

(ii) the charge that the battery supplies.

charge = ... [2]

9(a) Fig. 9.1 shows an electric circuit in which the internal resistance of the battery is negligible. The current supplied by the battery is 5.0 A.

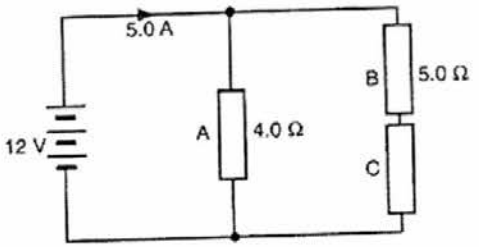

Fig. 9.1

(i) Calculate the current through resistor **A**.

current = ... [1]

(ii) Calculate the resistance of resistor **C**.

resistance = ... [2]

9(b) Fig. 9.2 shows a household electric circuit.
It consists of an air conditioner rated 200 V, 2 000 W and a lightning circuit rated 200 V, 400 W.
Both are connected in parallel to the mains supply of 200 V.

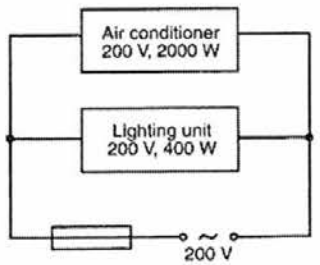

Fig. 9.2

(i) Explain the purpose of the fuse and its working principle.

.....

.....

.....

.....

.....[2]

(ii) By means of appropriate calculation, explain whether it is suitable to place a 10 A fuse in the circuit.

.....

.....[2]

10 Fig. 10.1 shows the structure of a circuit breaker that uses an electromagnet. The circuit breaker operates when the current is 10 A.

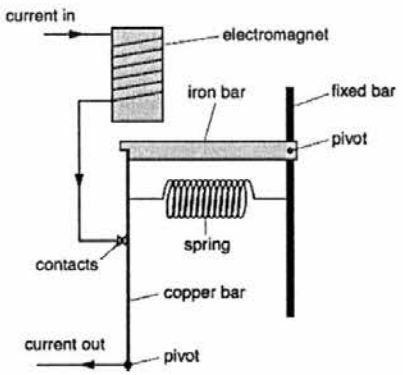

Fig. 10.1

(a) On Fig. 10.1, mark clearly with an arrow the force on the iron bar caused by the electromagnet. [1]

(b) Suggest one reason why the iron bar does not move when the current is less than 10 A.

.....

.....[1]

(c) When the current is greater than 10 A, the circuit breaker stops the current. Explain what happens in the circuit breaker when this occurs.

.....

.....

.....

.....

.....

.....[2]

(d) State how the electromagnet can be altered so that the circuit breaker stops the current at less than 10 A.

.....[1]

End of Section A

Section B: 20 marks

This section starts with question 11.
Answer any **two** questions in this section. Write your answers in the spaces provided.

11 A bungee jumper falls from a bridge above a river, as shown in Fig. 11.1.

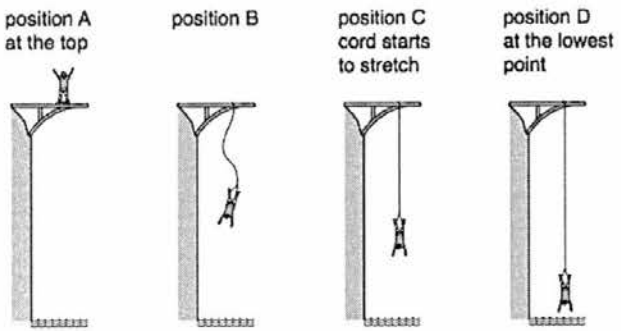

Fig. 11.1 (not to scale)

The man is at rest at position **A** in Fig. 11.1. The elastic cord starts to stretch at position **C** and he stops for the first time at position **D**. He continues to rise and fall.

Fig. 11.2 show the variation of velocity of the man with time *t*.

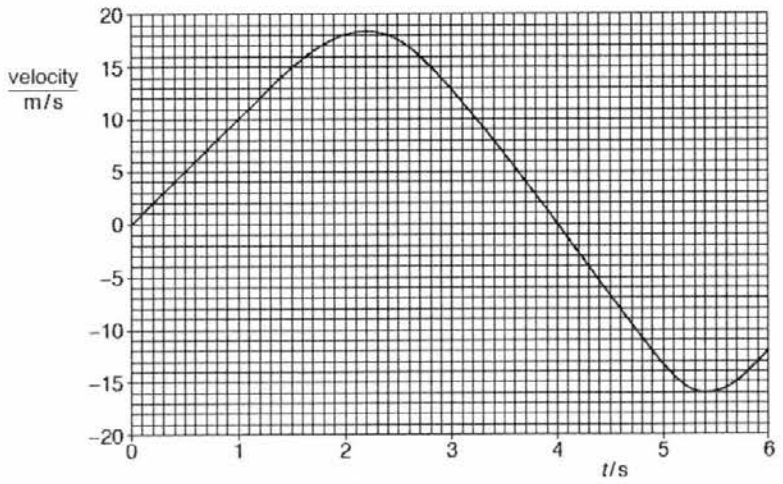

Fig. 11.2

(a) **(i)** State what is meant by velocity.

.....

.....[1]

(ii) Hence, state the difference between a positive velocity and a negative velocity.

.....[1]

(iii) In the first 1.2 s the acceleration is uniform.

Using the information provided in Fig. 11.2, find the acceleration of the man in the first 1.2 s.

acceleration = ... [2]

(iv) 1. State the value of *t* when the man is at position **D**.

.....[1]

2. Explain, in terms of the forces acting, why the man is accelerating upwards at position **D**.

.....

.....

.....

.....

.....[3]

(b) Ignoring the effect of air resistance, Fig. 11.3 shows the values for the gravitational potential energy of the man, the kinetic energy of the man and the elastic potential energy in the cord at **A**, **C** and **D**.

	gravitational potential energy/ J	kinetic energy/ J	elastic potential energy/ J
position **A**	20 000	0	0
position **C**	14 000	6 000	0
position **D**	0	0	20 000

Fig. 11.3

The man has a mass of 60 kg.
Using the information provided in Fig. 11.3, calculate the vertical distance between **A** and **C**.

distance = ... [2]

12 **(a)** A student makes a diagram of the molecules in a liquid, as shown in Fig. 12.1.

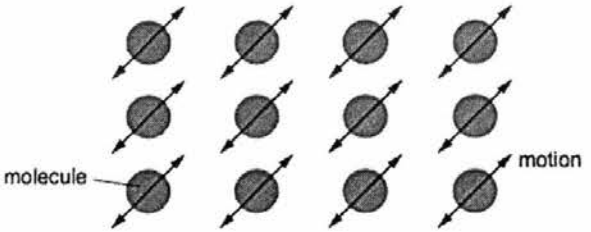

Fig 12.1

Suggest two ways in which the student's diagram does not show the positions and motion of the molecules accurately.

1. .....

.....

2. .....

.....
[2]

(b) Some of the molecules of a liquid evaporate.

(i) Describe what happens during evaporation.

.....

.....

.....[1]

(ii) Explain why evaporation has a cooling effect on the liquid.

.....

.....

.....

.....

.....[2]

(c) The beaker shown in Fig. 12.2 contains pure water at a temperature of 80 °C.

A thermometer, initially at room temperature, is placed in the air just above the water.

The reading on the thermometer starts to increase slowly.

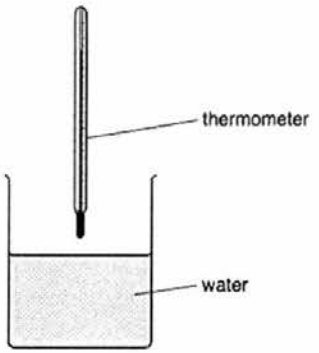

Fig. 12.2

(i) Briefly explain how convection in the air causes the reading on the thermometer to increase.

.....

.....[1]

(ii) A heater is placed underneath the beaker and the water boils vigorously to produce steam. The thermometer reading increases quickly.

Explain how the steam gives thermal energy (heat) to the thermometer.

.....

.....

.....

.....[2]

(d) State two differences between boiling and evaporation.

1. .....

2. .....

[2]

13 A sound wave travels through air.

(a) Explain the meaning of *wavelength*.

.....[1]

(b) Fig. 13.1 represents air molecules in the wave at a particular instant.

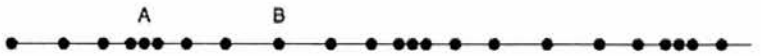

Fig. 13.1

(i) Describe the motion of a molecule of air due to the sound.

.....

.....

.....[2]

(ii) State one difference between the motion of molecule A and the motion of molecule B.

.....[1]

(c) A short pulse of sound waves produces an echo from a wall 20 m away. The echo arrives back at the source of the sound 0.12 s after the pulse is produced.

The wavelength of the sound wave is 30 mm.

(i) State what is meant by an *echo*.

.....[1]

(ii) Determine the speed of the sound.

speed = ... [2]

(iii) Calculate the frequency of the sound.

frequency = ... [2]

(iv) The sound wave produces compressions and rarefactions in the air as it passes.

Calculate the distance between a compression and the nearest rarefaction.

distance = ... [1]

End of Section B

Paper 1

1B	2A	3A	4B	5C	6D	7A	8C	9C	10A
11D	12D	13D	14A	15A	16C	17C	18D	19B	20B

Paper 2 Section A

1a	Mass, speed
1b	mass of paint = 7.0 – 0.50 = 6.5 kg density of paint = mass/volume = 6.5 / (5.0 x 10^{-3}) = 1 300 kgm^{-3}
2ai	Force moves through a distance in same direction / Body moves in the direction of the force.
2aii	chemical (potential) energy
2bi	Moment of weight about toes = 600 x 0.8 = 480 Nm
2bii	In equilibrium, taking moments about pivot (toes) sum of clockwise moment = sum of anti-clockwise moment *F* x 1.2 = 480 *F* = 400 N
3a	F = ma 500 - f = 1 500(0) f = 500 N
3b	F = ma New forward force – opposing force = ma 800 – 500 = 1 500a a = 300/1 500 = 0.2(0) ms^{-2}
4a	n = sin i/sin r = sin 45°/sin 29° = 1.46 sin c = 1/n c = sin^{-1} [1/n] = sin^{-1} [1/1.46] = 43°
4b	Light travels from optically denser to less dense medium angle of incidence at B is greater than critical angle total internal reflection occurs in prism comparing angles correctly (61°), (43°)

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5a	converging/convex lens
5b	correct arrows before and after lens correct solid and dotted lines ray through f, ray through optical centre image dotted and upright, at F label B
6a	c = 3(.00) × 10^8 m/s or 3(.00) × 10^5 km/s f = c/λ = 3.0 × 10^8 / (7.0 × 10^{-7}) = 4.29 × 10^{14} Hz
6b	Any one: radio waves, microwaves, infrared rays/radiation and its correct use
7a	Friction causes negative charges to move from hair / person / head to balloon balloon gains electrons/ has excess electrons
7b	Since **opposite/unlike charges attract** (Law of electrostatics) hair is positively charged (at end) attracted to negatively charged balloon
8a	the work done by a source in driving a unit charge around a complete circuit (or the energy released per unit charge)
8bi	E = Pt = 450× 5 400 (or 90/60) = 2.4(3) x 10^6 J (or 0.675 kWh)
8bii	Q = E/V = 2.4(3) x 10^6/ 18 = 1.3/1.35/1.4×10^5 C
9ai	I = V/R = 12/ 4.0 = 3.(0) A
9aii	Mtd 1 R_t = V/I = 12 /5.0 = 2.4 Ω $1/R_t = 1/R_A + 1/(R_B + R_C)$ 1/ 2.4 = 1/ 4.0 + 1/ (R_C + 5.0) R_C + 5.0 = 6.0 Ω R_C = 1.0 Ω Mtd 2 R_{B+C} = V/I = 12/2.0 = 6.0 Ω R_C = 6.0 - 5.0 = 1.0 Ω
9bi	Purpose of fuse is to protect the appliances in the circuit. When the current flowing in the circuit through exceeds the fuse rating.

	the fuse will melt and the circuit will be broken. This will disconnect the appliance from the high mains supply so the appliances will not overheat.
9bii	Total current in the circuit = $\frac{P_{ac} + P_{light}}{V}$ = 2 400/ 200 = 12 A Not suitable. Since current in circuit exceeds/more than 10 A, the appliances will not work.
10a	upward arrow (not curved) on iron bar
10b	Force of attraction or attractive force not strong enough/ weight of bar too high/ friction at pivot or with copper bar
10c	electromagnet works/ electromagnet strong enough/ magnetic field created attracts iron bar / iron bar moves or lifted up spring contracts/ pulls copper bar across contacts break circuit /contacts open
10d	More turns in coil/ larger iron core in electromagnet/ electromagnet nearer iron bar/ iron bar less weight / weaker spring

Section B

11ai	Distance travelled per second/unit time in a given direction Speed in a given direction/Displacement travelled/covered per unit time/ Rate of change of displacement/Change in displacement per unit time
11aii	Opposite direction
11aiii	a = (v-u)/t = (12 – 0)/(1.2-0) = 10 ms^{-2}
11aiv	1. 4.0 s
	2. *downward* weight or force due to gravity at D smaller than *upward* force/tension/elastic force from cord state correct direction for weight and tension Upward resultant/net force on man
11b	GPE = mgh h = 6 000/ (60 x 10) = 10 m
12a	liquid molecules not arranged regularly/orderly liquid molecules not moving in same direction/ about fixed position
12bi	Intermolecular bonds are broken. Molecules are able to leave the surface of the liquid.

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12bii	More energetic/ fast-moving molecules are able to escape. Leaves behind less energetic/ slower-moving molecules with lower average kinetic energy in liquid. Since temperature of liquid is directly proportional to average kinetic energy of molecules, temperature of liquid is lower/ liquid cools.
12ci	Air near the hot water gets heated. Hot air being less dense rises and touches the thermometer bulb.
12cii	steam condenses or changes to liquid on thermometer heat conducted from hot to cold gives out latent heat to thermometer
12d	Any two correct pairs of differences
13a	shortest distance between two points on the wave in phase
13bi	Oscillate/vibrate/move closer and further, backwards and forwards/ to and fro, parallel to/ in the direction of the wave motion
13bii	Move in opposite direction/ when A is on right of rest position, B is on left/ A molecule next move apart and B next move together
13ci	Sound that is reflected.
13cii	speed = distance / time = 40/0.12 (or 20/0.06) = 330 (or 333) m/s
13ciii	f = v/λ = 330/0.030 = 11 100 (or 11 000) Hz
13civ	λ = 30 mm/ 2 = 15 mm (or 0.015 m)